



Bluesil™  
Electrical applications guide

# Silicone Elastomers for electrical industries

## > Why choosing Silicone Elastomers for electrical applications?

- **Macromolecules with unlimited structural possibilities**

Silicones (or polyorgano-siloxanes) have a chemical structure based on alternating units of silicon and oxygen. The originality of silicones compared with natural silica, lies in the organic, carbon-containing groups that are included in their molecular framework.

According to the type of organic groups attached in this way, and the production and compounding methods used, a great variety of products can be obtained: their final texture can be free flowing, viscous or paste-like, elastomeric or even rigid.

- **A mineral - plastic hybrid**

The difference between silicones and other organic polymers (i.e. plastics) lies in the fact that they contain a semi-inorganic element, silicon bonded to oxygen atoms with Si-O- bonds.

The bonds formed between the silicon and oxygen atoms go to make up the macromolecular framework and are exceptionally stable. They are much more difficult to break than the carbon-carbon bonds found in organic polymers.

- **Stable, pure and high performance polymers for a wide range of applications in electrical industries**

Thanks to specific properties of Si-O-Si bond and ingredients purity, Silicone Elastomers show unique properties for many different electrical applications:

> Electrical cable, junctions and cable ends: High insulating performances with resistivity range from  $10^{+15}$  to  $10^{+16}$  W.cm.

> Safety cable: Thermo oxidative stability bringing high fire resistance, high ashes cohesion and non toxic smokes.

> Composite insulators and surge arresters: The excellent level of hydrophobicity and the outstanding recovery of hydrophobic properties after pollution, combined with UV and IR resistance means that Silicones are top performers in the polymers world.

> Potting: Very good fluidity of liquid Silicones (RTV-1 and RTV-2) and high insulating performances are particularly recommended in electric and electronic fields.

> Conformal coating and insulator impregnation: Remarkable spreadability of Silicone resins and adhesives associated with excellent temperature resistances are widely used for the protection of many supports.

### Main outstanding properties of silicone elastomers

- ◆ Excellent dielectric properties

- ◆ Very high heat stability : - 50°C up to 300°C (using specific additives).

- ◆ Outstanding resistance to natural aging agents (spray, bad weather, UV radiation, ozone, salt fog, etc.) as well as to climatic and industrial pollution.

- ◆ High long-term water repellency and outstanding ability to recover hydrophobic properties.

- ◆ Excellent tracking and erosion resistance.

- ◆ Excellent fire resistance and low emission of smoke.

- ◆ Non toxicity of residual gas.



## > Trust Bluestar Silicones for electrical applications

- **Recognized expertise**

With more than 50 years experience in the silicones rubbers, Bluestar Silicones proposes a wide range of specialized products for electrical applications. This range is composed by specific products for the production of electrical cables, composite insulators, surge arresters, cable ends but also by products for potting, conformal coating, insulator impregnation, etc. In order to obtain products always more powerful and adapted to all needs, Bluestar Silicones is working closer with you to define your specific requirements for the research and development of new products right through to the development of exclusive solutions.

- **A worldwide presence**

With production sites in all the continents and a worldwide logistics chain, Bluestar Silicones can supply quality products and services consistent in terms of performance level and adaptable to each specific use throughout the world.

- **Technical service: specialized teams in elastomers technology**

At Bluestar Silicones, electrical industry segment is managed by specialists who have an in depth knowledge of Silicones and their applications and many years of experience. Upon request, they are supporting customers for specific applications and guidance. Electrical industry teams are coordinated and supported by Tech Service Laboratory and its resources in Research, data-base and performance evaluation.

- **Analytical capabilities and approved industry sector tests**

With state-of-the-art equipment and unique know-how, our teams are able to select the best solutions in the laboratory before testing on-site. This helps to determine, with your team, the optimal solution for your needs.

- **Regulatory assistance adapted to the most demanding markets**

Our specialists have detailed knowledge of the evolution of standards and current regulations. They are capable of guiding you in terms of legislation as well as giving you regulatory assurance for all the most demanding applications.



## Bluestar Silicones Mix & Fix Centers® network

In order to be closer to your needs, Bluestar Silicones has specialized formulation and packaging units: the Mix & Fix Centers®.

Specialized in heat curing silicone rubbers (HCR), the Mix & Fix Centers® are located at the center of major rubber and elastomer converter regions. Besides selling master batches and other products, these centers develop, within extremely short lead times, products according to your specifications and your equipments.

The Bluesil™ HCR range can be utilized in two ways:

- Make up your own silicone elastomer batches
- Call your Mix & Fix Center® to
  - > Propose batch formulations.
  - > Prepare samples.
  - > Deliver ready-to-use compounds in the colors, presentation, and curing system of your choice.
  - > Formulate compounds containing some exclusive additives and catalysts (such as platinum catalyst).



### Cables

- ▶ Bluesil™ HCR
- ▶ Bluesil™ Resins & Adhesives
- ▶ Bluesil™ RTV-2

### Potting

- ▶ Bluesil™ RTV-2
- ▶ Bluesil™ RT Gel

### Coating & impregnating protection

- ▶ Bluesil™ Resins & Adhesives

### Composite insulators Surge arresters Cable ends

- ▶ Bluesil™ HCR
- ▶ Bluesil™ LSR
- ▶ Bluesil™ RTV-2
- ▶ Bluesil® Electroconductors

### Complementary range

- ▶ Bluesil™ ESA
- ▶ Bluesil™ CAF
- ▶ Bluesil™ Pastes
- ▶ Bluesil™ Primers



Bluestar Silicones offers a complete range of silicone elastomers for the electrical industry including numerous different technologies.

#### ▶ Bluesil™ HCR

Heat cure silicone elastomers are basically made from reactive silicone gums, linear and specific silica fillers. HCR have outstanding properties and are far superior to conventional organic elastomers. They exhibit exceptional mechanical strength at temperatures ranging from - 50°C up to + 300° C. The aging resistance of these elastomers highlights their fundamental qualities such as the fact they are chemically inert, their photo-oxidative stability and the absence of residual reactive groups once cured. A wide range of coloring is available. HCR are available as rubbery breads and supplied in two forms: master batches (without incorporated catalyst) or as ready to use compounds (through Bluestar Silicones' Mix & Fix Centers®).

#### ▶ Bluesil™ RTV-2

Bluesil™ RTV-2's are two-component liquid silicone elastomers. Their cure rate is generally slow at ambient temperature (pot life), but very quick at high temperature. The curing rate doubles every 10°C. Bluesil™ RTV-2's cure by a polyaddition reaction. They have two parts (A and B), mixed in a ratio of 100/100 (catalyst in A part) or 100/10 (catalyst in B part). Mixing the two components is obtained manually for small quantities and mechanically for quantities over 1 kg, in a rotary mixer or using dispenser pumps. These elastomers cure without releasing any by-products and there is consequently very little shrinkage.

#### ▶ Bluesil™ LSR

LSR are bi-component systems (90/10 or 50/50) which viscosities are generally included between 10 000 and 10<sup>+6</sup> mPas. This type of formulation forms an elastomeric network thanks to reactions of polyaddition in the presence of a platinum catalyst. The processing and product performance advantages of liquid silicon rubbers (LSR) are utilized in many existing and new applications. This type of rubbers can associate essential properties of silicon polymers and easy injection molding processing. After mixing A and B parts in a static or dynamic mixer, the largest means of transformation are: injection-molding machines working at medium or high pressures, or pumps directly feeding a mold at ambient pressure. These mixtures are vulcanizable from 60°C to around 150° C.

#### ▶ Bluesil™ Resins & Adhesives

Bluesil™ resins are siloxane polymers characterized by their three-dimensional branched-chain structure. Their preparation involves hydrolysis and polycondensation of silanes (mono, di- and tri-fonctional silanes and sometimes even tetrafonctional silanes). These "polymers", after completion of the reactions of polycondensation and cross

linking under the combined action of heat and catalysts (siccatives), yield flexible or rigid films, always hydrophobic and capable of resisting decomposition over long periods of time under high temperature without depolymerisation.

#### ▶ Bluesil™ RT Gel

Bluesil™ RT Gel are two-component silicone oils curing by polyaddition reaction. The viscosities of the two parts are generally included between 700 and around 7000 mPas. This low level of viscosity allows a very easy mixing of two components which can be performed manually or mechanically for higher quantities (over 10Kg). After two components mixing, the very fluid liquid is transformed after curing into a self elastic, translucent gel. Curing takes place without any heat release but can be accelerated by heating.

In order to answer all your needs in term of electrical insulation, Bluestar Silicones has developed a complementary range including three different technologies.

#### ▶ CAF (RTV-1)

CAF are one component liquid silicone elastomer curing at room temperature on contact with atmospheric humidity. On contact with air moisture, CAF cure liberating an oxime, an alcohol or acetic acid depending on their cure type. Processing is particularly easy, since the products are delivered ready to use. Application can be carried out either manually or using robotic equipment. Their cure rate can be considerably accelerated by increasing temperature and humidity. After curing, CAF are transformed into silicone elastomers offering very good mechanical properties, good heat stability and high dielectric properties.

#### ▶ Bluesil™ Pastes

Bluesil™ Pastes are made of a polydimethyl siloxanic oil thickened with inert fillers. Bluesil™ Pastes are mainly used as sealants and electrical insulants. Their main properties are:

- > High dielectric properties.
- > Excellent resistance to high temperatures, without hardening or degradation.
- > Exceptional resistance to water and many chemical agents.
- > Good resistance to oxidation.
- > Strong anti-adherent characteristic.

#### ▶ Bluesil™ ESA

Bluesil™ ESA are two component Adhesive Silicone Elastomers (ESA) curing very quickly (within a few minutes) at high temperatures (+ 120° C to 200° C) - (Polyaddition reaction). After polymerisation, Bluesil™ ESA form a flexible adhesive film which is particularly resistant to thermal, climatic and environmental attacks. Bluesil™ ESA are designed for bonding to silicone elastomers, metal or plastic surfaces in Electrical industries.

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**BLUESTAR**  
**SILICONES**

# Bluesil™ Silicone Grades for Cables

## > Bluestar Silicones offer a specific range for the manufacture of electric cables

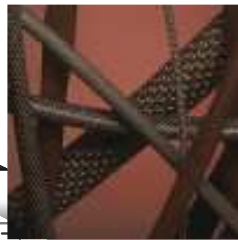
- The composition of the master-batches, additives, color bases has been specially designed to meet with the highest dielectric, heat stability and fire resistance requirements.
- A particular attention has been given to ease-of-use, and to extrusion performance.
- The range offers economical solutions through the possibilities of extending and high vulcanizing speeds covering all market sectors.
- The products have been designed to be in accordance with requirements of international standards and specifications.



• Cables appliances & automotive



• Fire protection cables  
Safety cables



• Silicone coating for glass braid



• Silicone resins for glass/mica tapes coating

## > Advantages of Bluesil® Silicone elastomers

- Excellent dielectric properties.
- Very high heat stability : - 50°C up to 300°C (using specific additives).
- Exceptional resistance to aging factors : UV rays, ozone, corona effect, salt fog... in humid and hot conditions.
- High heat conductivity.
- Excellent resistance to fire and non toxicity of residues and gas, low emission of smoke (Bluesil™specialties).

# Bluesil™ HCR for Cables

Properties	Standards	Units	General purpose										High properties				High ash cohesion												
			MF 8140 U			MF 8150 U			MF 8160 U		MF 8170 U	MF 8270 U		MF 8360 U		MF 8370 U		MF 8465 U*											
			Unfilled	Extended Ground quartz		Unfilled	Extended Ground quartz		Unfilled	Extended Ground quartz																			
-	50 phr	100 phr	-	50 phr	100 phr	-	50 phr	75 phr																					
General characteristics	Appearance		Translucent	Off-white		Translucent	Off-white		Transparent	Off-white		Transparent	Off-white		Transparent	Transparent		Off-white											
	Specific Gravity	ISO 1826	(g/cm³)	1,10	1,35	1,50	1,11	1,36	1,54	1,15	1,42	1,61	1,16	1,32		1,15		1,18		1,23									
Mechanical properties without post cure	Catalyst type		E	E	E	E	E	E	E	E	E	E	E	L	E	L	E	L	E	L									
	Hardness, shore A	ASTM D 2240	48	63	76	48	64	75	62	71	79	71	69	70	59	63	64	68	72	68									
	Tensile strength	ISO R37	(MPa)	6,7	7,3	7,9	8,3	8,9	8,7	11,4	9,5	8,5	10,8	9,3	9,8	10,7	10,3	10,3	9,5	8	8								
	Elongation at break	ISO R37	(%)	380	200	125	570	330	195	415	250	200	330	305	350	620	720	570	640	240	310								
	Tear strength	ASTM D 624 A	(kN/m)	12	14	14	15	14	14	25	17	16	20	21	21	38	39	40	40	16	19								
Rebound resilience		(%)	67	-	-	60	-	-	51	-	-	53	53	48	44	47	40	38	47	48									
Mechanical properties after 10 days at 200 °C	Hardness, shore A	ASTM D 2240	45	63	76	48	61	73	65	76	87	75	75	79	65	72	75	79	80	78									
	Tensile strength	ISO R37	(MPa)	5,5	7,4	8,1	6,3	7	7	8,5	7,4	7,1	8,3	8,3	7,9	7,3	6,6	6,2	5,6	7,2	6,6								
	Elongation at break	ISO R37	(%)	320	170	110	450	250	170	350	160	90	235	185	195	310	260	200	140	170	170								
Dielectric properties	Dielectric strength (on 1 mm thick slabs)	IEC 60243	(kV/mm)	26			28			28		28		31		28		26		27		32		28		30			
	Dielectric constant at 1 MHz	IEC 60250		2,7			2,7			2,8		3,2		5,4		5,8		2,4		2,2		2,3		2,8		2,1		3,2	
	Dissipation factor at 1 MHz	IEC 60250		4,5 x 10 <sup>-3</sup>			4,4 x 10 <sup>-3</sup>			4 x 10 <sup>-3</sup>		4,8 x 10 <sup>-3</sup>		4,4 x 10 <sup>-3</sup>		4,2 x 10 <sup>-3</sup>		3,8 x 10 <sup>-3</sup>		2,6 x 10 <sup>-3</sup>		4,1 x 10 <sup>-3</sup>		3,7 x 10 <sup>-3</sup>		5,6 x 10 <sup>-3</sup>		5,4 x 10 <sup>-3</sup>	
	Volume resistivity	IEC 6093	(Ohm.cm)	1,3 x 10 <sup>15</sup>			1,5 x 10 <sup>15</sup>			2 x 10 <sup>15</sup>		2,9 x 10 <sup>15</sup>		4,2 x 10 <sup>15</sup>		4,2 x 10 <sup>15</sup>		1,5 x 10 <sup>15</sup>		2,1 x 10 <sup>15</sup>		2,6 x 10 <sup>15</sup>		3,3 x 10 <sup>15</sup>		1,1 x 10 <sup>15</sup>		1,2 x 10 <sup>15</sup>	
Oxygen Index (LOI)	ASTM 2863	(%)	-	34	37	-	37	40	-	37	39	-	34		-		-		-		28								

\* Bluesil™ MF 8465 U is used in cable construction satisfying fire resistance and ashes cohesion standards, such as IEC 32070CR1, BS 6387C, W, Z, EN 50200...

## Mix & Fix Centers®

The Bluesil range can be utilized in two ways

- Make up your own silicone elastomer batches.

- Call your Mix & Flix Center® to produce your ready to use product in accordance with your specifications and your processing conditions.

## Processing method

Silicones cables are obtained by extrusion process and can be vulcanized by different technologies.

- Hot air without pressure.
- Salt melted bath.
- Steam under pressure (6 to 20 bars).

The peroxide type is determined by the vulcanization process as recommended in the table below

Catalysts	Bluestar name	Vulcanising technique
2,4 dichlorobenzoyl peroxide	E	Without pressure hot air extrusion Melted salt bath extrusion
Dimethyl-2,5 bis (tertiobutylperoxy)-2,5 hexane	L	Extrusion in steam at 12 to 20 bars pressure
Dicumyl peroxide	D	Extrusion in steam at 6 to 12 bars pressure

## Additives

Processing enhancing additives

Additive	Objective
Additive AD 717	Incorporation of fillers Plasticity adjustment
Additive DA 22	No sticking to conductor

Performance enhancing additives

Additive	Objective
Additive AD 916	Prevention of blooming in non-post cured parts vulcanised with 2,4 dichlorobenzoyl peroxide (acid acceptor)
Additive AD 720	Increased resistance to hot oils
Additive HFR 1	Improved fire resistance
Additive HAC 5	Improved ashes cohesion
Additive AD 744	Increased heat stability up to 250 °C
Additive AD 703	Increased heat stability up to 300 °C



## Mica tapes

Bluestar Silicones proposes a complete range of Silicones Resins for Glass/Mica tapes coating.

> To know all those products, please consult the Conformal Coating data file.



## Glass braids

For glass braid impregnation, Bluestar Silicones propose Bluesil™TCS series providing excellent barrier protection against chemical and environmental aggression, such as fire, heat, moisture, aging and mechanical stress. In perfect accordance with your specifications and processing conditions, Bluesil™TCS series offer a complete range of silicone solutions.

> For more information please consult the Bluesil™TCS brochure.

## Colors

Coloring Bluesil™master batches is easy by using Bluesil™color bases (pigments premixed into the silicone gum).

> To know all the available Bluesil™color bases please consult the Bluesil™General guide brochure.



# Standards and specifications

The Bluesil™ elastomers for the manufacture of electric cables have been designed to meet with the requirements of the international and European standards.

	Non fire propagation		Non flame propagation			Fire resistance		Fire resistance and ashes cohesion			
	NFC 32070 C1	IEC 60 332-3	NFC 32070 C2	IEC 60 332-1,2 VDE 0472-804 A, B	NFC 32310	IEC 60 331 VDE 0472 section 814	BS 6387 C and W classes	NFC 32070 CR1	BS 6387 Z class	DIN 4102 part 12	EN 50200
Cable length	Cable sample 1600 mm	Cables sheet 4 m	600 mm	600 mm	700 mm	1200 mm	C: 1200 mm W: 1500 mm	1300 mm (Geometry: linear)	Up to 1200 mm (Geometry: Z)	Cables sheet Minimum length 3 m	Up to 1200 mm (Geometry : U)
System	Test chamber + chimney (h = 800 mm/ ø 125 mm)	Vertical test chamber + ladder (h = 4 m)	Vertical 3 sided metallic screen	Vertical 3 sided metallic screen (H = 1200 mm)	Vertical chimney	Horizontal stand	C: horizontal stand W: horizontal stand Gas burner: 610 mm + water sprayed system	Horizontal furnace + mechanical shocks system + tube + checking lamp system	Vertical ladder + mechanical shocks system + water sprayed system + checking lamp system	Furnace	Vertical stand + optional mechanical shocks and water sprayed systems
Heating System	Radiation furnace + forced ventilation + test flames	Gas burner length 341 mm + forced ventilation	2 gas burner for ø ≥ 50 mm	A: 1: gas burner if ø < 50 mm 2: gas burner if ø > 50 mm B: gas burner ø 9,5 mm	Bunsen burner	Burners ramp positioned 75 mm under the sample	C: Gas burner: 610 mm W: Gas burner	Furnace	4 Gas burners	Oil burner	Gas burners Length 500 mm
Trial Temperature	760°C	800°C	400°C	A: 400°C B: variable		750°C	C: 950°C W: 650°C (± 40°C)	900°C	950°C	1: 847°C 2: 950°C 3: 1011°C	830°C
Trial Duration	30 mm	Depend on the volume of burned material (l/m)	Fonction of the cable weight T= 60 + M/25	A: Fonction of the cable weight T= 60 + M/25 B: 15 s	5 x 15 s (time between 2 exposures: 15 s)	IEC 60 331: 3h VDE 0472: 20 min	C: 3h W: 15 min	50 + 15 min	15 min	1: 30 min 2: 60 min 3: 90 min	30 to 120 min
Voltage								300 or 600 V	300/500 V or 450/750 V	110 or 400 V	600/100V
Shocks frequency								2 per min	2 per min		1 each 5 min
Requirements	No damage on the external part of the cable (out of the chimney)	Height of burned section ≤ 2 m 50 from the lower part of the gas burner	Self extinguishing No damage over the upper limit of the sample	A: Equivalent to NFC C2 B: Self extinguishing + burned section 50 mm minimum under the upper fastening strap	Time of combustion after exposure < 1 min No continuous damage up to 35 mm from the lower limit	No breakdown of insulation during the test and 12h after when re-starting the voltage	No lamp switched off No short circuit	No cut of conductor No short circuit No leakage current up to 0,5 A	No lamp switched off No short circuit	No short circuit	

## Non corrosive and non toxic smokes

NFC 20454 or IEC 60 754-1:

Analysis and proportioning of gas given off by combustion (HX concentration).

NFC 20453 or IEC 60 754-2:

Measurement of smoke pH (1<pH<9) and conductivity (<10 micro S/mm).

## Opacity smokes

NFC 20902/1 or 2-1:

Measurement on ASTM slab (0,5 m³ chamber)

IEC 60 1034-1 and 2/BS 7629:

Measurement on complet cable (27 m³ chamber).

## Mechanical properties and thermal ageing

EI 2 or EI 5:

- Initial properties : elongation at break > 150 % ; tensile strength > 5 MPa

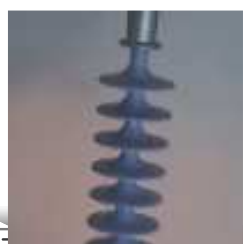
- After ageing 10 days at 200 °C: elongation at break > 120 % ; tensile strength > 4 MPa.

# Bluesil™ Silicone Grades for Composite insulators, surge arresters & cables ends

Bluestar Silicones offers a complete and specific range of silicone elastomers to manufacture high performance, long life elastomeric housings for composite insulators, surge arresters and cable junctions.

Those can be silicone rubber (HCR) or liquid silicones (LSR, RTV-2).

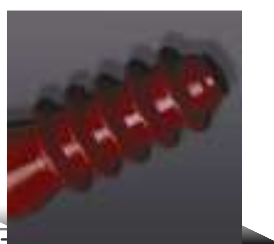
Thus, they offer a broad range of viscosities in perfect adequacy with transformation techniques. These products are innovating and powerful to adapt to the evolutions of the standards in force.



● Composite insulator



● Surge arrester



● Cable end

## > Advantages of Bluesil® Silicone elastomers

- Outstanding resistance to natural aging agents (spray, bad weather, UV radiation, ozone, salt fog, etc.) as well as to climatic and industrial pollution.
- Very good tracking resistance, excellent arc resistance and electrical erosion.
- Good fire behavior.
- Stability of physical and electrical properties.
- Excellent hydrophobicity with high hydrophobic recovery capacity in polluted area.

	Glass ceramic	EPDM	Bluesil™ Silicone Rubber
Initial hydrophobicity	+	+	++
Hydrophobic recovery	--	--	++
Light weight	--	+	++
Contamination resistant	--	--	++
Leakage current control	--	--	++
Resist weather	+	+	++
Low cost installation/breakage	--	+	++
Resist UV	+	+	++

# Bluesil™ Grades for Composite insulators

Properties	Standards	Units	HCR (Heat Cure Rubbers)			LSR (Liquid Silicone Rubber)			HCR Electroconductors		
			MF 8970 L SP2	MF 8965 L TR	MF 8975 D HTR	Low viscosity LSR	Fluid LSR		EC 1050 D	EC 1065 D	EC 1075 D
						LSR 8230 QCS A & B	LSR 8540 SFR A & B	LSR 8555 HTR A & B			
Appearance			Light grey	Light grey	Light grey	Light grey	Light grey	Light grey	-	-	-
Specific Gravity	ISO R 1123		1,54	1,52	1,58	1,12	1,08	1,27	1,11	1,16	1,22
Ratio A/B components			-	-	-	90/10	50/50	50/50	-	-	-
Viscosity	Brookfield	(MPa.s)	-	-	-	16 000	145 000	120 000	-	-	-
Post cure			None	None	None	None	None	None	4 hours at 200 °C	4 hours at 200 °C	4 hours at 200 °C
Shore A hardness	ISO 868		73	66	77	32	42	55	53	64	77
Tensile strenght	ISO R37	(MPa)	6,5	5,2	6	5	6,5	6	6	7	7,5
Elongation at break	ISO R37	(%)	200	360	200	350	370	200	250	220	170
Tear strenght	ASTM D 624 A	(kV/m)	17	19	15	15	28	16	14	15	16
Dielectric strength (Thickness: 2 mm)	IEC 60243	(kV/mm)	20	20	21	25	25	23	-	-	-
Strike-over voltage (Thickness: 2 mm)	IEC 60243	(kV)	41	41	42	-	-	-	-	-	-
Dielectric constant at 1 Mhz	IEC 60250		3,2	3,2	3,3	2,9	2,9	3	-	-	-
Dissipation factor at 1 Mhz	IEC 60250		5 x 10 <sup>-3</sup>	5 x 10 <sup>-3</sup>	9 x 10 <sup>-3</sup>	5 x 10 <sup>-3</sup>	3 x 10 <sup>-3</sup>	3 x 10 <sup>-3</sup>	-	-	-
Volume resistivity	IEC 60093	(Ohm.cm)	7 x 10 <sup>14</sup>	6 x 10 <sup>14</sup>	5 x 10 <sup>14</sup>	1 x 10 <sup>15</sup>	2 x 10 <sup>15</sup>	2,5 x 10 <sup>15</sup>	7	5	3
Tracking resistance	IEC 60587	(kV)	3,5	4,5	5	3,5	-	4,5	-	-	-
Fire resistance	IEC 60707		FV 0-3 mm	FV 0-3 mm	FV 0-2 mm	FV 0-3 mm	-	FV 0-1 mm	-	-	-
Oxygen limit index (ILO)	ASTM 2863	(%)	39	-	40	-	-	40	-	-	-
Salt fog resistance	HN-26-E-20		Certified	-	-	-	Certified	Certified	-	-	-

\* For curing conditions, please refer to specific Technical data sheets.

## Processing method

> For the production of composite insulators and surge arrestors, the choice of the silicone type depends on several essential parameters:

- The dimension of the article. Actually, an insulator can have very variable dimensions:
  - > Diameter: from a few centimeters to more than one meter
  - > Length: from a few centimeters to several meters.
- Production yield : limited series (hollow core type) or large series (long rod type).
- The design of the parts: simple or complex.
- Customer's processing conditions and technical constraints.

Article dimensions	Large dimensions (important diameters)		Low dimensions or long length and small diameter	
Design	Complex		Simple	
Production	Limited series		Limited series	Large series
Choice of Silicone Elastomer	LSR low viscosity	LSR fluid	LSR fluid	LSR fluid HCR
Moulding method used	Automatic casting or low injection pressure	Injection low or medium pressure	Injection low or medium pressure	Compression transfert Injection medium or high pressure

## Comprehensive technical assistance, close at hand...

Bluestar Silicones, with its 2 Research and Development centers and its 5 European RTV and Mix & Fix production centers, has fully dedicated scientific and technical teams providing service to those who design and produce insulators and surge arresters.

Bluestar Silicones offers a customized service, working with them to develop products tailored to the market, providing high technical performance and economically competitive.

## Mix & Fix Centers®

The Bluesil range for electrical applications can be utilized in two ways

- Make up your own silicone elastomer batches
- Call your Mix & Fix Center® to produce your ready to use product in accordance with your specifications and your processing conditions.



> Other LSR products can be found in the General guide Brochure

# Standards and specifications

The Bluesil™ elastomers for the manufacture of insulators have been designed to meet the requirements of national, European and international standards.

	Tests performed on						
	Slab samples						Final parts
	IEC 60 587	ASTM D 2303	IEC 60 112	HN 26-E-20 (EDF)	DIN VDE 0441	ASTM D 495	IEC 60 1109
Normalizes evaluations	Tracking and erosion resistance under liquid contaminant 5 tilted plane test-tubes Method 1: test with constant tension (class 1A) Method 2: test by stage of tension (class 2A)	Tracking and erosion resistance under liquid contaminant 5 tilted plane test-tubes Test by stage of tension	Index of resistance and behaviour to the advance under wet conditions - 5 plane test-tubes - contaminating Liquid: 50 drop/trial water + 0,1 % NH4Cl (solution A) Or water + 0,1 % NH4Cl + surface-active agent (solution B)	Tracking and erosion resistance under climatic aging - 504 h of salt fog test under electrical stress - 1008 h of climatic aging at 70°C - 504 h of salt fog test under electrical stress	1: resistance to leak current under high voltage (HK) 2: arc resistance under high voltage (HL) 3: resistance to breakdown by diffusion under high voltage (HD)	Arc resistance under high voltage and weak current - 5 plane test-tubes - tension = 12 500 V Test by stage of tension from 10 to 40 mA	Composite insulators for outdoor power lines with tension >1 000 V Test 1: metal extremities (interfaces and connexions) (3 insulators) Test 2: tracking and erosion on composite coating (6 insulators)
Criteria	Final point if: - I > 60 mA - cheminement > 25 mm	Final point if: - I > 60 mA - cheminement > 25 mm	Maximal depth of erosion < 1 mm	Test 1: final point if: - I > 60 mA - cheminement > 1 mm Test 2: mechanical variations properties < 50 %		Length of erosion < 1,6 mm	Test 1: - tension of dry skirting - thermomechanical test - water penetration test (42 h in boiling water + 0,1 % NaCl) Test 2: - salt fog 1 000 h at 20 °C - inflammability test
Classification	- Classe 1A-2,5/3,5/4,5 - Classe 2A-2,5/3,5/4,5	The highest tension held without defect by the 5 test-tubes during 1 hour	- ITC (tension) - IRC (tension) + depth of erosion		1: classe HK 0 to 3 (2,5 to 4,5 kV) 2: HL 0 to 4 (0 to 420 seconds) 3: HD 0 to 2 (0 to 12 kV)	Test duration: from 0 to 420 seconds	Test 1: no visible tracking, no perforation Test 2: no visible tracking, no perforation, IEC 60 707: FV0

# Bluesil™ Silicone Grades for Coating and impregnating protection

## > Advantages of Bluesil™ resins

Bluestar Silicones offer a broad range of Silicone resins. After drying and crosslinking, these resins form flexible or rigid films that confer remarkable properties to the treated surfaces.

Their heat stability is outstanding: resins offer effective protection at high temperatures (typically in the range of 200°C and over for short period of time).

They resist well to oxidation and have good dielectric properties. These remarkable characteristics make them particularly suitable for numerous electrical and electronic applications, such as: insulation of printed circuit, electronic assemblies of flexible materials, impregnation of glass cloth braids, braided cables, mica tapes, electrical motor coils, etc.



● Motor windings



● Mica tapes



● Printed circuit

## Bluesil™ resins for Coating and impregnating protection

		Resins and adhesives							
	Properties	Standards	Units	R 991	Adhesive 8805	R 8160 M	R 8060 M	R 8170 P	R 8152 P
General properties	Appearance			Colorless	Colorless	Colorless	Colorless	Colorless	Colorless
	Solvent			Xylen	Toluene	Toluene	Toluene	Toluene	Toluene
	Specific gravity	ISO R 1183		1,03	0,96	1,07	1,00	1,11	1,00
	Viscosity at 23°C		(mPa.s)	175	3 000 to 6 000	10 to 20	2 500	100	170
	Dry content		(%)	50	55	60	60	70	50
	Flash point (closed cup)		(°C)	25	6	< 0	16	4	7
Dielectric properties	Dielectric strength	IEC 60243	(kV/mm)	80	-	20	-	20	-
	Dielectric constant at 100 Hz	IEC 60250		2,7	2,8	2,7	2,9	2,8	2,7
	Dissipation factor at 100 Hz	IEC 60250		1 x 10 <sup>-3</sup>	1 x 10 <sup>-3</sup>	1 x 10 <sup>-3</sup>	1 x 10 <sup>-3</sup>	1 x 10 <sup>-3</sup>	1 x 10 <sup>-3</sup>
	Volume resistivity	IEC 60093	Ω.cm	1 x 10 <sup>14</sup>	5 x 10 <sup>14</sup>	1 x 10 <sup>15</sup>	8 x 10 <sup>14</sup>	1 x 10 <sup>15</sup>	1 x 10 <sup>15</sup>

### Silicone resins and adhesives

Resins are relatively low molecular weight polymers with a three dimensional branch-chained structure. They are generally available diluted in an aliphatic or aromatic solvent to reduce their viscosity.

They are used in diverse applications to improve durability, safety and reliability.

### Key performance properties

- **Heat and weather resistances**

Thanks to the high bonding energy of the siloxane bonds, the temperature of thermal decomposition is very high which explains their excellent heat and weather resistances.

- **Electrical insulation**

Silicone resins preserve their very high electrical properties over a wide range of temperatures.

- **Water repellency**

Thanks to the outstanding mobility of siloxane bonds and the orientation of the non polar methyl groups in the molecular structure, the surface of the cured material presents an excellent water repellency.

- **Rigid or flexible structures**

Silicone resins are highly branched 3-dimensional polymers. After crosslinking, the backbone structure of the cured material can be either rigid or flexible depending on specific formulations.

- **High adhesion behaviour**

Specific grades are available in order to maximize the adhesion between many different substrates (ie: glass clothes, mica tape, etc.).

# Bluesil™ Silicone Grades for electrical industry Complementary range

> In order to provide optimum service, Bluestar Silicones has developed a complementary range of various type of products.

- Primer application

Adhesion promoters formulated to achieve a cohesive adhesion between Silicone/metal and Silicone/epoxy resins during vulcanization process (i.e epoxy rods, metallic clamps in composite insulator applications).

- Bonding

Mono component or bi-component elastomers tailored to secure a cohesive adhesion between:

- > Cured elastomers.
- > Cured elastomers and other substrates.

- Local insulation and protection

Mono component elastomers (fluid or in dispersion) used as coating to promote a specific protection of glass and ceramic insulators. Silicone pastes intended for in situ protection of electrical device, such as electrical connexions, circuit breakers, cable terminals and other distribution accessories in corrosive or humid atmospheres.



● Electrical protection

## Bluesil™ complementary range for electrical applications

	Properties	Standards	Units	CAF (RTV-1)		Adhesive (RTV-2)	Pastes	
				CAF 4 dispersion	CAF 4	ESA 7244 A & B	PASTE 4	PASTE M 494
General properties	Natural color			Off-white		A: beige / B: blue	Translucent to whitish	
	Odour Ratio A/B			Acetic		-	-	
	Specific gravity			-		50/50	-	
	Viscosity	ISO R 1183		1,02	1,16	1,25	1,0	1,0
		Brookfield	(mPa.s)	6 500	250 000	A: 95 000 / B: 35 000	penetration (1/10 mm)	
	Solid content at 105°C		(%)	72	-	-	-	-
	Flash point	closed up	(°C)	< 0	-	-	-	-
Curing	Temperature 23°C and relative humidity 50%							
	Skin formation time		(min)	12	10	-	-	-
	Time required to cure 2 mm		(hour)	4	5	-	-	-
	Curing conditions			7 days at room temperature		10 min at 150°C	-	
Mechanical properties after curing	Shore A hardness	ISO 868		34	37	50	-	-
	Tensile strenght	ISO R37	(MPa)	3,6	3,8	5,5	-	-
	Elongation at break	ISO R37	(%)	310	290	> 160	-	-
	Tear strenght	ASTM D 624 A	(kN/m)	4,2	4,5	-	-	-
Electrical properties	Dielectric strength (thickness: 1 mm)	IEC 60243	(kV/mm)	21	21	19	> 20	> 20
	Dielectric constant at 1 Mhz	IEC 60250		2,9	2,9	2,9	2,6	2,6
	Dissipation factor at 1 Mhz	IEC 60250		$2 \times 10^{-3}$	$2 \times 10^{-3}$	$3 \times 10^{-3}$	$5 \times 10^{-4}$	$1 \times 10^{-4}$
	Volume resistivity	IEC 60193	Ω.cm	$1 \times 10^{15}$	$1 \times 10^{15}$	$1,5 \times 10^{15}$	$> 10^{13}$	$> 10^{13}$
Fire resistance	Fire resistance	IEC 60707		-	-	FV1 (3 mm thick specimen)	-	-
	Oxygen index	NFT 51071	(%)	-	-	40	-	-

### CAF 4 and CAF 4 dispersion

CAF 4 and CAF 4 dispersion are one component elastomers which cure at room temperature (acetic systems).

Processing is particularly easy, since the products are delivered ready to use:

- CAF 4 dispersion can be carried out using a spray gun. This product is particularly recommended to coat glass or ceramic insulators.
- CAF can be carried out either manually or using robotic application equipment.

CAF 4 and dispersion CAF 4 start curing as soon as the products come into contact with atmospheric moisture. After curing, they have very good mechanical properties, good heat stability and high dielectric properties.

### Bluesil™ Adhesive ESA 7244 A & B

Bluesil™ Adhesive ESA 7244 A & B is solventless. Its low viscosity enables easy coating and covering.

After polymerization, Bluesil™ Adhesive ESA 7244 A & B is transformed into a flexible adhesive film which is particularly resistant to thermal, climatic and environmental attack.

So, the outstanding resistance to climatic and aging agents ensures that the product carries out its functions for a long time. Bluesil™ Adhesive ESA 7244 A & B is intended for bonding to metal, plastic and epoxy surface in various electrical applications.

### Bluesil™ Pastes 4 and M 494

Bluesil™ Pastes 4 and M 494 are polydimethylsiloxanic oils based silicone paste together with inert fillers.

These pastes are particularly adapted to protection and insulation of electrical switchgear and to protection applications against humidity.

These pastes, chemically inert and highly hydrophobic, present excellent dielectric properties and a very good stability of properties over a wide temperature range.

### Adhesion of Bluesil™ HCR, LSR and RTV to the insulator cores

To obtain maximum adhesion of the elastomer on the core it is necessary to use a preliminary surface treatment. Bluesil™ PM 820 or PM 811 A & B are the universal primers recommended for Bluesil™ RTV, LSR and HCR. Our technical departments are also able to provide specific solutions that correspond both to your performance requirements and to the type of insulator core.

# Bluesil™ Silicone Grades for Potting

## > Advantages of Bluesil™ Silicone elastomers

There is no limit of the use of liquid silicone elastomers in the electrical and electronic industries, especially when protection of components against harmful environmental effects is required.

Encapsulating, potting, impregnating, dipping, filling and casting are some examples of applications which can be considered.

Polyaddition curing systems are the preferred insulating materials for these applications.

Their acceptance is due to several factors including their excellent dielectric properties, mechanical strength, shock resistance, moisture resistance, excellent adhesion properties, aging and chemical resistance.

Their ease of processing is also a well appreciated asset.



● Electronic protection



● Electronic device encapsulation

## Bluesil™RTV-2: Two component polyaddition silicone elastomer systems

Properties	Standards	Units	RTV 141 A and B		RTV 147 A and B		RTV 148 A and RTV 147 B		RTV 149 A and B		RTV 1523 A and B	
			A	B	A	B	A	B	A	B	A	B
Part			Translucent	Translucent	Beige	Pale blue	Beige	Pale blue	Beige	Pale blue	Black	White
Appearance			Translucent	Translucent	Beige	Pale blue	Beige	Pale blue	Beige	Pale blue	Black	White
Specific Gravity	ISO R 1183		1,02	1,02	1,24	1,25	1,23	1,25	1,24	1,25	1,31	1,45
Viscosity at 23°C (shear rate 1s <sup>-1</sup> )	ASTM D 445	(mPa.s)	3 500	650	150 000	10 000	10 000	10 000	40 000	10 000	3 000 - 6 000	2 000 - 6 000
A and B ratio (part)			100	10	100	10	100	10	100	10	50	50
Viscosity of the mixture of part A and B		(mPa.s)	3 000		150 000		10 000		40 000		3 000 - 6 000	
Pot life at 25°C			4 hours		2 hours		4 hours		2 hours		1 hour 30 min	
Cure			1 hour at 150°C		1 hour at 150°C		1 hour at 150°C		1 hour at 150°C		8 hours at 23°C	
Hardness, shore A	ASTM D 2240		50		60		40		58		50	
Tensile strength	ISO R37	(MPa)	6		6		3,5		6		2,5	
Elongation at break	ISO R37	(%)	120		180		160		135		150	
Secant modulus at 100 % elongation	ASTM D 412	(MPa)	-		3,2		2,2		-		-	
Tear strenght	ASTM D 624 A	(kN/m)	-		> 15		-		17		-	
Compression set (22 h/177°C/25%)	ASTM D 395 B	(%)	-		-		-		-		-	
Rebound resilience		(%)	-		-		-		-		-	
Dielectric strength (thickness: 2 mm)	IEC 60243	(kV/mm)	20		18		18		19		18	
Dielectric constant at 1 Mhz	IEC 60250		2,7		2,9		2,9		2,9		3,2	
Dissipation factor at 1 Mhz	IEC 60250		1 x 10 <sup>-3</sup>		3 x 10 <sup>-3</sup>		3 x 10 <sup>-3</sup>		2 x 10 <sup>-3</sup>		5 x 10 <sup>-3</sup>	
Volume resistivity	IEC 60093	(Ω.cm)	1 x 10 <sup>15</sup>		-		-		-		8 x 10 <sup>13</sup>	
Fire resistance	UL 94		-		-		-		-		VO - 3,4 thick	
Limit oxygen index	AFNOR NFT 51-071	(%)	-		-		-		-		40	

## Bluesil™RT-GEL: Two component polyaddition silicone oil systems

Properties	Standards	Units	Potting		Jonctions filling
			RT Gel 8260 A and B	RT Gel 8208 A and B	RT Gel 8210 A and B*
Appearance			Transparent		Clear blue
Ratio A/B			1/1		1/1
Viscosity at 23°C (shear rate 1s <sup>-1</sup> )		(mPa.s)	A: 6 300 - B: 5 800		A: 1 280 - B: 960
Pot life at 23°C			1 hour		1 hour
Penetration after curing from 1 h 30 at 80°C	ASTM D 217	(1/10 mm)	220		180
Dielectric strength	IEC 60243	(kV/mm)	-		18
Dielectric constant at 1 kHz	IEC 60250		-		2,8
Power factor at 1 kHz	IEC 60250		-		1 x 10 <sup>-3</sup>
Volume resistivity	IEC 60093	Ω.cm	-		1 x 10 <sup>15</sup>

### Deep-section curability

The curing reaction proceeds uniformly at the surface and internally, regardless of elastomer thickness.

### Adjustability of cure speed

Cure time can be adjusted by changing the heating conditions.

\* Bluesil™ RT Gel 8210 A and B is specially designed for applications requiring NO BLEEDING EFFECT.